

PCT

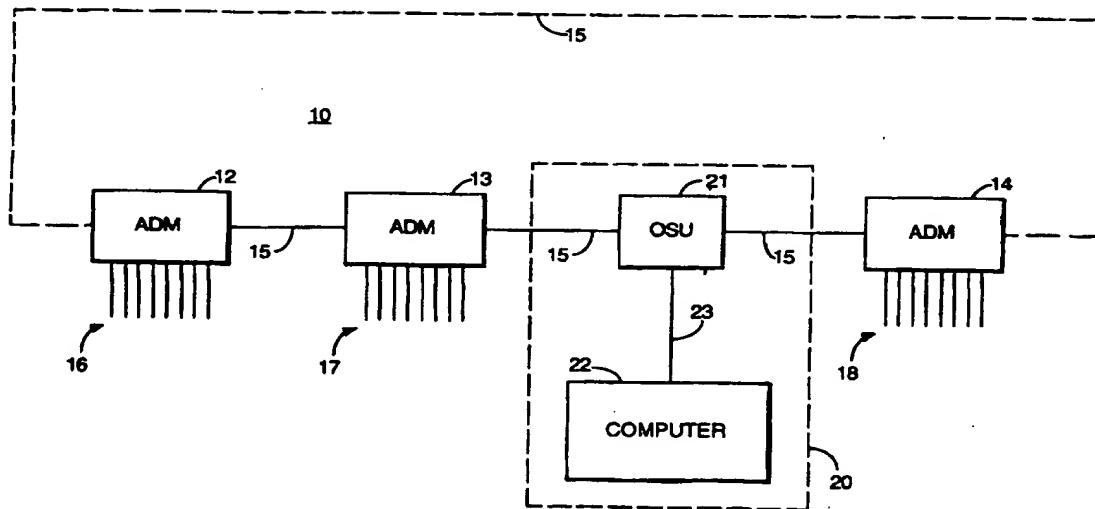
WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ :		A1	(11) International Publication Number: WO 97/37453
H04J 3/16, 3/14			(43) International Publication Date: 9 October 1997 (09.10.97)
(21) International Application Number: PCT/GB97/00752		(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).	
(22) International Filing Date: 18 March 1997 (18.03.97)			
(30) Priority Data: 08/624,298 29 March 1996 (29.03.96) US			
(60) Parent Application or Grant (63) Related by Continuation US Filed on 08/624,298 (CIP) 29 March 1996 (29.03.96)			
(71) Applicant (for all designated States except US): BRITISH TELECOMMUNICATIONS PUBLIC LIMITED COMPANY [GB/GB], 81 Newgate Street, London EC1A 7AJ (GB).		Published With international search report.	
(72) Inventor; and (75) Inventor/Applicant (for US only): HERSEY, Paul, Christian [US/US]; 43761 Woodworth Court, Ashburn, VA 20147 (US).			
(74) Agent: EVERSHED, Michael; BT Group Legal Services, Intellectual Property Dept., 8th floor, 120 Holborn, London EC1N 2TE (GB).			

(54) Title: MONITORING A SYNCHRONOUS DIGITAL HIERARCHY TRANSMISSION PATH



(57) Abstract

There is described a system for monitoring utilisation of a tributary (17) to a main SDH transmission path (15). The main SDH transmission path is arranged to transport a series of data frames, each of which contains virtual containers. A data signal from tributary (17) is loaded into virtual containers reserved to carry the data signal. The monitoring system (20) comprises an optical service unit (21) and a computer (22). The optical service unit (21) monitors the bytes of the virtual containers reserved to carry the tributary for the presence of a predetermined bit pattern and transmits a report containing the results of the monitoring to the computer (22). In the computer (22), the data contained in the report is used to evaluate utilisation of the tributary. One example of the bit pattern which is monitored is the presence of all binary "1"s in each byte of the payload of a virtual container.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakhstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

MONITORING A SYNCHRONOUS DIGITAL HIERARCHY TRANSMISSION PATH

This invention relates to a method of monitoring transmission along a synchronous digital hierarchy transmission digital path and also to a system for 5 monitoring such transmission.

In a synchronous digital hierarchy (SDH) network, tributaries to a main SDH transmission path are connected to it by multiplexers. The tributaries and multiplexers connect terminal equipment belonging to users of the network to the main transmission path. Within the main transmission path, bandwidth is allocated 10 between the users of the network in accordance with their requirements and these requirements vary with time. Because the bandwidth of the main transmission path is limited, at any moment in time it may happen that the bandwidth requirement of a particular user is not met in full. It has been appreciated by the inventor of the invention which is the subject of this patent application that a 15 particular user may not be making full use of the bandwidth allocated to it. Therefore, if such underuse of an allocated bandwidth could be detected, it might be possible to persuade the user to reduce its bandwidth requirement. This could then free additional bandwidth for the user if this requirement was not met in full. It has therefore been appreciated that it is desirable to find a method of monitoring 20 utilisation of tributaries to a main SDH transmission path.

According to one aspect of this invention, there is provided a method of operating a utilisation monitoring system for monitoring utilisation of a tributary to a main synchronous digital hierarchy (SDH) transmission path, said main transmission path being arranged to transport a series of data frames each of 25 which contains at least one virtual container, each virtual container having a path overhead and a payload, the said tributary joining the main transmission path at a multiplexer which is arranged to load a data signal from the said tributary into virtual containers in said frames which are reserved for carrying a data signal from the said tributary, the said method comprising the steps of:

30 examining virtual containers reserved for carrying a data signal from the said tributary at a point on the said main transmission path for the presence of a predetermined bit pattern; and

evaluating a parameter indicative of the utilisation of said tributary from the results of said examining step.

The present invention provides a method of monitoring utilisation of a tributary to a main SDH transmission path. It can be used to detect underuse of an allocated bandwidth requirement by a user who might then be persuaded to reduce its bandwidth requirement. As mentioned above, bandwidth freed in this way could then be made available for a user whose bandwidth requirement was not met. It can also be used to monitor utilisation of a tributary to detect when bandwidth usage approaches a point where additional bandwidth should be purchased.

According to another aspect of this invention, there is provided a system for monitoring utilisation of a tributary to a main synchronous digital hierarchy (SDH) transmission path, said system comprising:

means for examining virtual containers carried in SDH data frames and reserved for carrying a tributary to a main SDH transmission path at a point on the main SDH transmission path for the presence of a predetermined bit pattern; and means responsive to said examining means for evaluating a parameter indicative of the utilisation of the tributary.

This invention will now be described in more detail, by way of example, with reference to the drawings in which:

Figure 1 is a block diagram of some components of an SDH network including a monitoring system embodying this invention;

Figure 2 is a diagram of an SDH STM-1 data frame together with a VC-4 virtual container;

Figure 3 is a diagram of an SDH STM-1 data frame together with virtual containers arranged in a nested manner;

Figure 4 is a block diagram of the components of the computer shown in Figure 1;

Figures 5 and 6 are flow charts illustrating the operation of the monitoring system shown in Figure 1; and

Figure 7 is a diagram illustrating a display produced by the monitoring system.

Referring now to Figure 1, there are shown some of the components of an SDH network. These components include a ring 10 of add/drop multiplexers. Three of these multiplexers are shown and indicated, respectively, by reference numerals 12, 13 and 14. Between the multiplexers 12, 13 and 14, data is carried 5 along a main transmission path 15. Between the multiplexers 12 and 13 and the multiplexers 13 and 14, the main transmission part is indicated by a solid line and this indicates that no further multiplexers are located along this part of the transmission path. Between the multiplexers 12 and 14, the transmission path is indicated by a dashed line and this indicates that additional multiplexers, not 10 shown, are located along this part of the transmission path. Each of the add/drop multiplexers 12, 13 and 14 has tributaries and these are denoted, respectively, by reference numerals 16, 17 and 18. The ends of the tributaries remote from the add/drop multiplexers are connected to terminal equipment belonging to the users 15 of SDH network. Thus, the tributaries and add/drop multiplexers connect terminal equipment to the main transmission path 15.

The SDH network also includes a monitoring system 20 which comprises an optical service unit 21 located on the main transmission path 15 between add/drop multiplexers 13 and 14 and a computer 22. The optical service unit 21 is an optical service unit type OSU 155 manufactured by GRC International Inc of 20 8310 Guildford Road, Suite A, Columbia, Maryland, USA, but modified to operate as herein described. The optical service unit 21 and the computer 22 are connected by a communications link 23. As will be described in detail below, the function of the monitoring system 20 is to monitor utilisation of tributaries to the main transmission path 15.

25 Between the add/drop multiplexers data is carried in STM-1 data frames. (STM stands for Synchronous Transport Module). STM-1 frames are clocked at intervals of 125 microseconds. SDH standards define higher order dataframes which are clocked at higher frequencies. Higher order data frames will not be described in this example. Whilst not shown, the SDH ring 10 may be connected 30 to another SDH ring by a crossconnect and in such a further SDH ring data may be carried in higher order STM modules.

An example of an STM-1 frame 30 is shown in Figure 2. As is known to those skilled in the art, an STM-1 frame comprises a section overhead 31 and a

payload 32. The section overhead 31 contains control information. The payload 32 contains data to be transported. Each STM-1 frame is 2430 bytes long, with 81 bytes in the section overhead 31 and 2349 bytes in the payload 32.

Within each STM-1 frame, the payload holds one or more virtual 5 containers which contain the data to be transported. SDH standards define a set of virtual containers of varying byte lengths. In Figure 2, there is shown a VC-4 virtual container which is the largest container that can be carried by an STM-1 frame. Each virtual container has a path overhead which contains control information and a payload which contains the data to be transported. In the virtual 10 container 33 shown in Figure 2, the path overhead is indicated by reference numeral 34 and the payload is indicated by reference number 35.

Where an STM-1 frame contains smaller virtual containers, the smaller containers are loaded into larger containers in a nested manner. Figure 3 shows an STM-1 frame 40 in which VC-12 virtual containers 41 are nested into VC-3 virtual 15 containers 42, and the VC-3 virtual containers 42 are nested into a VC-4 virtual container 43.

At an add/drop multiplexer a tributary may be loaded into virtual containers carried by the data frames passing along the main transmission path. The data signal in the tributary is loaded into a type of virtual container which has 20 an appropriate byte length and hence appropriate bit rate capacity to receive data carried at the bit rate of the tributary. The data signal from the tributary is loaded into a single virtual container in each data frame. Data may also be unloaded from virtual containers into a tributary. For the STM-1 frame, the VC-12 virtual container has a bit rate capacity of 2.3 Mbit/s and is thus capable of receiving a 25 plesiochronous digital hierarchy (PDH) data signal at a bit rate of 2.048Mbit/s. The bit rate capacity of each type of virtual container corresponds to one or more PDH bit rates as shown in Table 1 below.

Table 1

Virtual Container	Capacity (Mbit/s)	Corresponding PDH Capacity (Mbit/s)
VC-4	150	139.264
VC-3	50	34.368 & 44.736
VC-2	6.8	6.312
VC-12	2.3	2.048
VC-11	1.7	1.544

In the present example, the tributaries 16, 17 and 18 carry PDH data signals at a bit rate of 2.048 Mbit/s. The add/drop multiplexers 12, 13, 14 are arranged to load the PDH data signals from the tributaries 16, 17, 18 into VC-12 containers. However, it is to be appreciated that the present invention may be used for monitoring tributaries operating at different bit rates and loaded into different types of virtual containers.

In order to provide a user of the network 10 with a bandwidth allocated to that user, one or more virtual containers are reserved in each STM-1 frame, to carry the data for the customer. For example, if the user whose terminal equipment is connected to the network by the eight tributaries 16 and add/drop multiplexer 12 requires sufficient bandwidth to carry data signals on all eight tributaries, the bandwidth requirement can be met by reserving 8 VC-12 virtual containers in each STM-1 frame. If this user requires sufficient bandwidth to carry the data signal from just one tributary, then this requirement may be met by reserving a single VC - 12 virtual container in each data frame.

Each tributary to an SDH network may be unequipped or equipped. If it is unequipped, it is unused and therefore unable to carry useful data, which can be interpreted as being idle. If the tributary is equipped, it is able to carry useful data and it is either busy or idle. If it is busy it is carrying data and if it not busy then it is not carrying data.

The monitoring system 20 is arranged to monitor the utilisation of one or more tributaries. In order to monitor the utilisation of a tributary, it examines the bytes in virtual containers reserved to carry a data signal from that tributary. The

monitoring system 20 evaluates utilisation of a tributary in three different ways, each of which is based on a particular condition. These conditions will now be described.

In the first condition, the optical service unit 21 examines each byte in the 5 payload of a virtual container for the presence of all "1"s, or, in other words, for a binary value of "11111111". If each byte of the payload of the virtual container has all binary "1"s, then the condition is met. This condition will be referred to as the "ALWAYS" condition. Where each byte of the payload of the virtual container is reserved to carry the data signal for a particular tributary has an all binary "1"s 10 value, this indicates that the tributary is idle for the time segment corresponding to the virtual container regardless of whether the virtual container is equipped or unequipped. Thus, where the "ALWAYS" condition is met in the virtual container reserved for a particular tributary in a whole series of frames, then for the time period corresponding to the series of frames the tributary is completely idle. If the 15 "ALWAYS" condition is met for only half of the frames, then the tributary is 50% utilised.

An evaluation of utilisation based on the "ALWAYS" condition will be accurate only in so far as the "ALWAYS" condition is a reliable indicator of utilisation. Because the bytes within the payload of a virtual container are liable to 20 drift, it can happen that the "ALWAYS" condition may not be met for a particular tributary, despite the fact that the tributary is idle.

In the second condition for measuring utilisation, the bytes of the payload of a virtual container are examined for the presence of at least one byte having an all binary "1" s value, or in other words, a binary value of "11111111". This 25 condition will be referred to as the "ONCE" condition. Thus, where the bytes in a virtual container have drifted, an evaluation of utilisation based on the "ONCE" condition may be more accurate than an evaluation based on the "ALWAYS" condition.

The path overhead of each VC-12 virtual container contains a byte which 30 is known as the "V5" byte. If in the V5 byte, bits 5, 6 and 7 are set to a binary value of "000", this indicates that the tributary for which the virtual container is reserved is unequipped. In the third condition for measuring utilisation, the V5 byte of the path overhead of a virtual container reserved for a particular tributary is

examined for the presence of a binary "OOO" in bits 5, 6 and 7. If this value is found, then this condition is met. This condition will be referred to as the "UNEQUIPPED" condition. The "UNEQUIPPED" condition identifies an unused, that is idle, tributary. Thus, if the "UNEQUIPPED" condition is met, in the virtual 5 container reserved for a particular tributary in each frame of a series of frames, then the tributary is "UNEQUIPPED" for the time period corresponding to the series of frames. If the unequipped condition is not met for any of these virtual containers, then the tributary is equipped for the time period corresponding to this series of frames.

10 It is to be noted that the three conditions for measuring utilisation share the common feature of examining the bytes of a virtual container for the presence of a pre-determined bit pattern. The difference between the three conditions lies in the actual bit pattern which is detected.

15 The optical service unit 21 extracts and monitors the bytes of the frames passing along the main transmission path 15 in order to provide network management information. In addition to providing conventional network management information, the optical service unit 21 can also monitor virtual containers reserved for up to eight tributaries for the presence of the "ALWAYS" condition, the "ONCE" condition and the "UNEQUIPPED" condition. The optical 20 service unit 15 monitors virtual containers for the presence of the three conditions for a series of polling intervals each of which has a duration of 125 milliseconds. Thus, each polling interval corresponds to 1,000 STM-1 frames. During each polling interval, the optical service unit 21 monitors the virtual containers for each tributary.

25 During each polling interval the optical service unit 21 examines each virtual container reserved for a particular tributary for the presence of the "ALWAYS" condition. At the end of the polling interval, the optical service unit 21 logs the number of virtual containers which satisfy the "ALWAYS" condition.

30 Similarly, during each polling interval, the optical service unit 21 monitors each virtual container reserved for a particular tributary for the presence of the "ONCE" condition. At the end of the polling interval, it logs the total number of virtual containers in that interval which satisfy the "ONCE" condition.

During each polling interval, the virtual containers reserved for a particular tributary are monitored for the presence of the "UNEQUIPPED" condition. At the end of the polling interval, it logs the number of virtual containers which have been examined for the "UNEQUIPPED" condition which satisfy this condition.

5 At the end of each measurement period, which in the present example, is 5 seconds, the optical service unit 21 produces a report. For each monitored tributary, the report specifies the number of polling intervals (usually 40), the number of virtual containers which satisfy the "ALWAYS" condition, the number of virtual containers which have satisfied the "ONCE" condition and the number of 10 virtual containers which have been found to satisfy the "UNEQUIPPED" condition. A report is generated and transmitted to computer 22 on communications link 23.

The computer 22 uses the reports from the optical service unit 21 to evaluate utilisation of the monitored tributaries. The computer 22 is of conventional construction and its main components are shown in Figure 4. As 15 shown in Figure 4, the components of computer 22 comprise a central processing unit 50, a visual display unit (VDU) 51, a store 52, keyboard 53 and input and output ports 54. The store 52 is formed from hard-disk store, random-access-memory and read-only-memory. The store 52 contains the programs which control the operation of computer 22 and also the program which is used for evaluating 20 tributary utilisation.

For each measurement period, for each monitored tributary the computer 22 evaluates three parameters U_A , U_O and U_E indicative of utilisation of the tributary. The three parameters U_A , U_O and U_E are based, respectively, on the "ALWAYS" condition, the "ONCE" condition and "UNEQUIPPED" condition. For 25 each measurement period, the computer 22 also calculates three parameters U_{AA} , U_{AO} and U_{AE} for the average utilisation of the monitored tributaries. The flow chart for the part of the program which is used to calculate the three parameters U_A , U_O and U_E for each individual tributary is shown in Figure 5 and the part of the program which is used to evaluate the three parameters for the average of the 30 three tributaries is shown in Figure 6. These two flow charts will now be described.

Referring now to Figure 5, in a step 60, the computer 22 evaluates a parameter U_A which represents utilisation of the monitored tributary based on the "ALWAYS" condition using the following equations:

5 $U_A = (1 - I_A)$, where(1)

$$I_A = P_A / Q_A$$

P_A = number of virtual containers reserved for the tributary examined in the measurement period which satisfy the "ALWAYS" condition

Q_A = total number of virtual containers reserved for the tributary examined in measurement period

10

The value of Q_A , which represents the total number of virtual containers reserved for the tributary examined in the measurement period, is obtained by multiplying the number of polling intervals in the measurement period by 1,000.

15 There are 1,000 frames in each polling interval.

In a step 61, the computer evaluates a parameter U_O which represents the utilisation of the monitored tributary based on the "ONCE" condition using an equation which is similar to Equation 1 set out above but modified for the "ONCE" condition.

20 In a step 62, the computer 22 evaluates a parameter U_E which represents the utilisation of the monitored tributary based on the "UNEQUIPPED" condition using an equation which is similar to Equation 1 above but which is modified for a the "UNEQUIPPED" condition.

25 Referring now to Figure 6, in a step 65, a parameter U_{AA} which represents the average utilisation of the monitored tributaries based on the "ALWAYS" condition is evaluated in accordance with Equation 2 set out below:

$$U_{AA} = \left(1 - \frac{\sum_{n=1}^N I_{An}}{N} \right), \text{ where}(2)$$

$$I_{An} = P_{An} / Q_{An}$$

20 P_{An} = number of virtual containers reserved for monitored tributary n examined in the measurement period which satisfy the ALWAYS condition

Q_{An} = total number of virtual containers reserved for monitored tributary n
examined in measurement period

N = number of monitored tributaries

5

In the present example, the number of monitored tributaries N may have a value of up to 8.

10 In a step 66, a parameter U_{AO} representing the average utilisation of the monitored tributaries based on the "ONCE" condition is evaluated in accordance with an equation similar to Equation 2 set out above but modified for the "ONCE" condition.

15 Lastly, in step 67, a parameter U_{AE} representing the average utilisation of the monitored attributaries based on the "UNEQUIPPED" condition is evaluated in accordance with an equation similar to Equation 2 set out above but modified for the "UNEQUIPPED" condition.

Each of the parameters representing tributary utilisation may be displayed on VDU 51 for successive time periods by using a bar chart. An example of a bar chart is shown in Figure 7. As may be seen, for each measurement period the parameter is displayed as percent utilisation.

20 The steps 60 to 62 and 65 to 67 are performed effectively simultaneously at the end of each measurement period and the six parameters may then be displayed at the same time.

25 Thus, by using the monitoring system 20, an operator may monitor both the individual and average utilisation of the monitored tributaries. By evaluating the utilisation in accordance with the three different conditions, the reliability of the evaluation is improved. If the operator finds that either a single tributary or a group of monitored attributaries is underused, he may suggest to the user of that tributary or tributaries that it would be appropriate to reduce the user's bandwidth requirement. If the user does reduce its bandwidth requirement, then the spare 30 bandwidth may be allocated to another user who may require additional bandwidth. Also, if the operator finds that the bandwidth usage of a single tributary or a group of monitored tributaries is approaching a point where additional

bandwidth should be purchased, he may suggest to the user of that tributary or tributaries that it would be appropriate to purchase additional bandwidth.

Although the present invention has been described with respect to monitoring tributaries to an SDH ring in which the tributaries operate at a PDH bit rate of 2.048 Mbits, it is to be appreciated that the present invention may be applied to monitoring utilisation of tributaries which operate at other bit rates. Also, the present invention may be used for monitoring utilisation of tributaries to an SDH transmission path which is arranged along a line, rather than in a ring.

In this specification, the expression "synchronous digital hierarchy network" is intended to include a network operating to synchronous optical network (SONET) standards. These standards are considered a subset of SDH standards.

CLAIMS

1. A method of operating a utilisation monitoring system for monitoring utilisation of a tributary to a main synchronous digital hierarchy (SDH) transmission path, said main transmission path being arranged to transport a series of data frames each of which contains at least one virtual container, each virtual container having a path overhead and a payload, the said tributary joining the main transmission path at a multiplexer which is arranged to load a data signal from the said tributary into virtual containers in said frames which are reserved for carrying a data signal from the said tributary, the said method comprising the steps of:

examining virtual containers reserved for carrying a data signal from the said tributary at a point on the said main transmission path for the presence of a predetermined bit pattern; and

evaluating a parameter indicative of the utilisation of said tributary from the results of said examining step.

2. A method of operating a utilisation monitoring system in Claim 1, in which, in said evaluating step, said parameter U is evaluated for each one of a series of measurement periods in accordance with the following equation:

20

$U = (1 - I)$, where

$I = P/Q$

P = number of virtual containers examined in measurement period
having said bit pattern

25 Q = total number of virtual containers examined in measurement period

3. A method of operating a utilisation monitoring system as claimed in Claim 1 or Claim 2, in which said predetermined bit pattern is the presence of all binary 30 "1"s in each byte of the payload of a virtual container.

4. A method of operating a utilisation monitoring systems as claimed in Claim 1 or Claim 2, in which said predetermined bit pattern is the presence of all binary "1"s in at least one byte in the payload of a virtual container.

5 5. A method of operating a utilisation monitoring system as claimed in Claim 1 or Claim 2, in which said predetermined bit pattern is the presence of a bit pattern in the path overhead of a virtual container which indicates that the tributary is unequipped.

10 6. A system for monitoring utilisation of a tributary to a main synchronous digital hierarchy (SDH) transmission path, said system comprising:
means for examining virtual containers carried in SDH data frames and reserved for carrying a tributary to a main SDH transmission path at a point on the main SDH transmission path for the presence of a predetermined bit pattern; and
15 means responsive to said examining means for evaluating a parameter indicative of the utilisation of the tributary.

7. A system for monitoring utilisation of a tributary to a main SDH transmission path as claimed in Claim 6, in which the said evaluating means is
20 arranged to evaluate the said parameter U for each one a series of measurement periods in accordance with the following equation:

U = (1 - I), where
I = P/Q
25 P = number of virtual containers examined in measurement period
having said bit pattern
Q = total number of virtual containers examined in measurement period

8. A system for monitoring the utilisation of a tributary to a main SDH
30 transmission path as claimed in Claim 6 or Claim 7, in which said predetermined bit pattern is the presence of all binary "1"s in each byte of the payload of a virtual container.

9. A system for monitoring utilisation of a tributary to a main SDH transmission path, as claimed in Claim 6 or Claim 7, in which set predetermined bit pattern is the presence of all binary "1"s in at least one byte of the payload of a virtual container.

5

10. A system for monitoring utilisation of tributary to a main SDH transmission path as claimed in Claim 6 or Claim 7, in which said predetermined bit pattern is presence of a bit pattern in the path overhead of a virtual container which indicates that the tributary is unequipped.

10

11. A system for monitoring utilisation of tributary to a main SDH transmission path as claimed in any one of Claims 6 to 10, further including means for displaying said parameter.

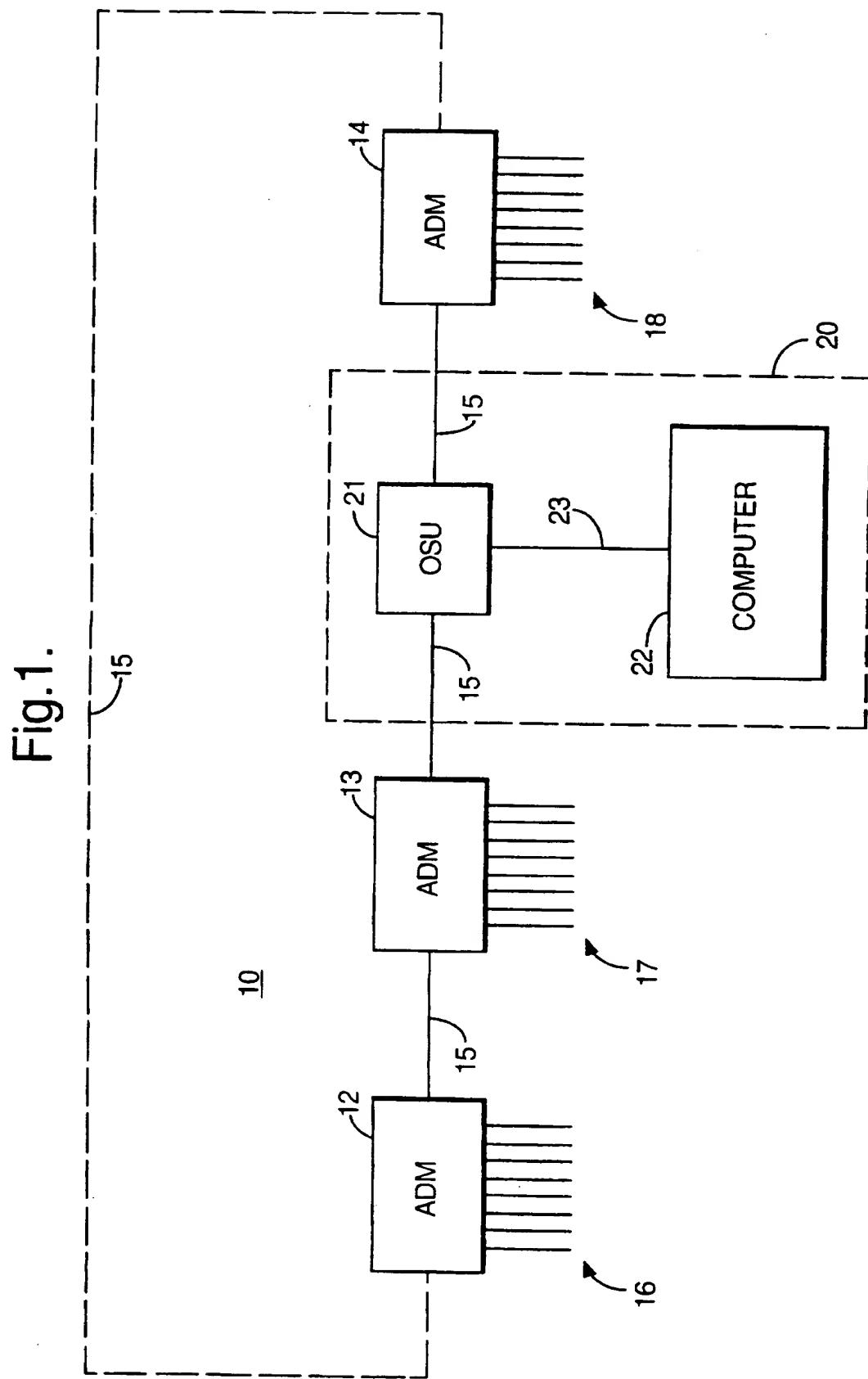


Fig.2.

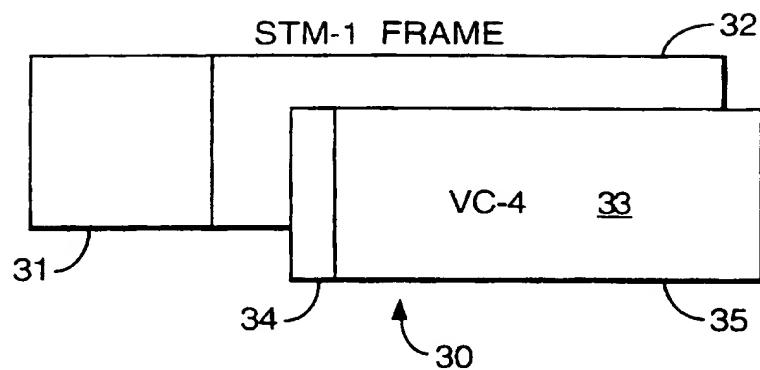


Fig.3.

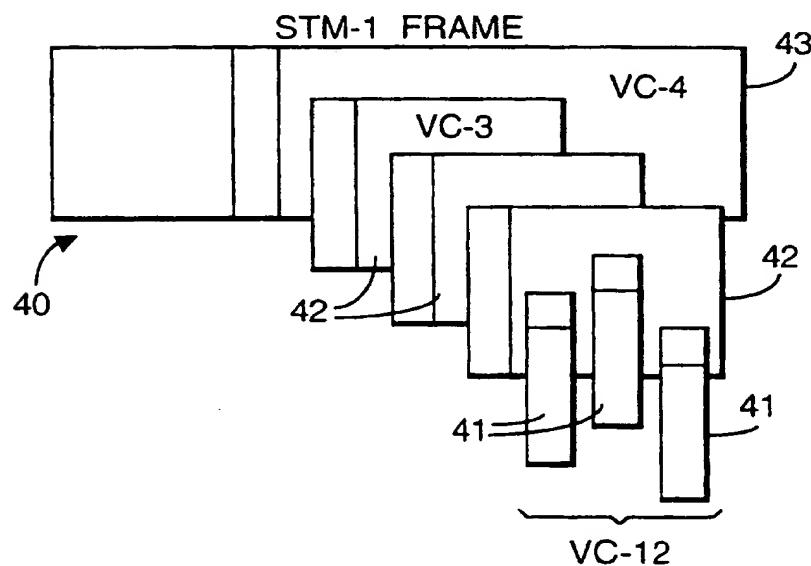


Fig.4.

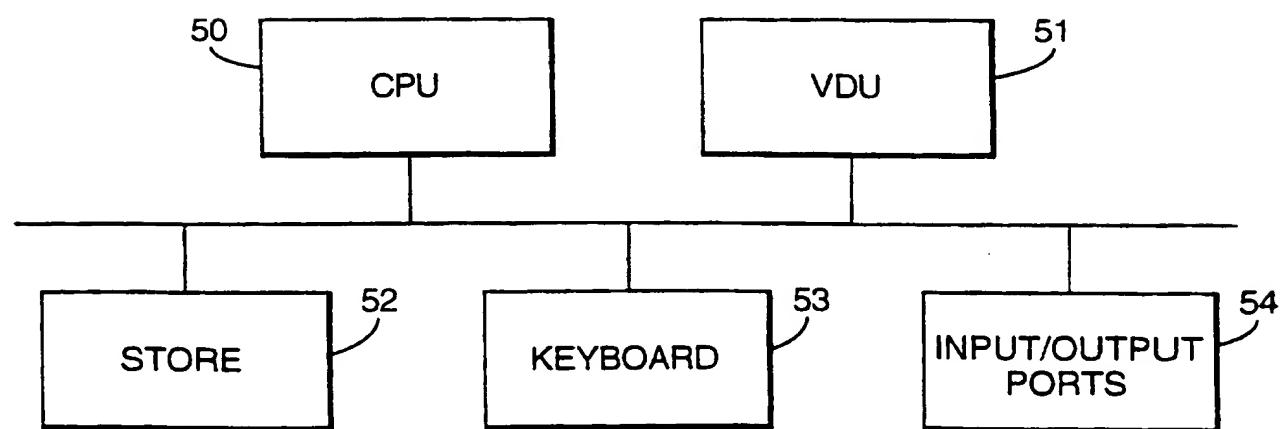


Fig.5.

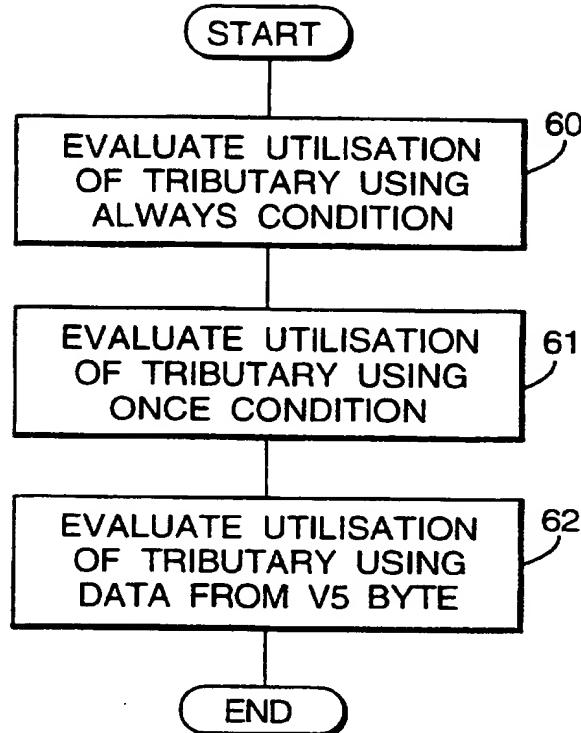


Fig.6.

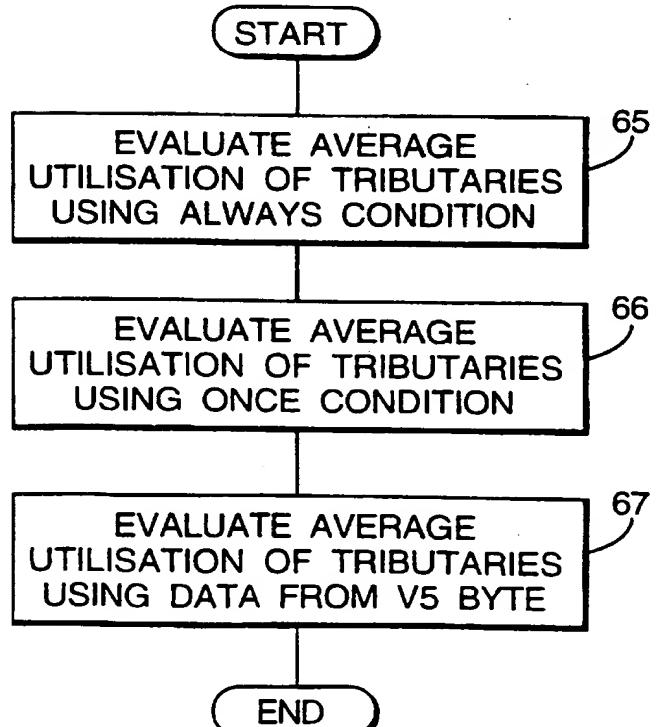
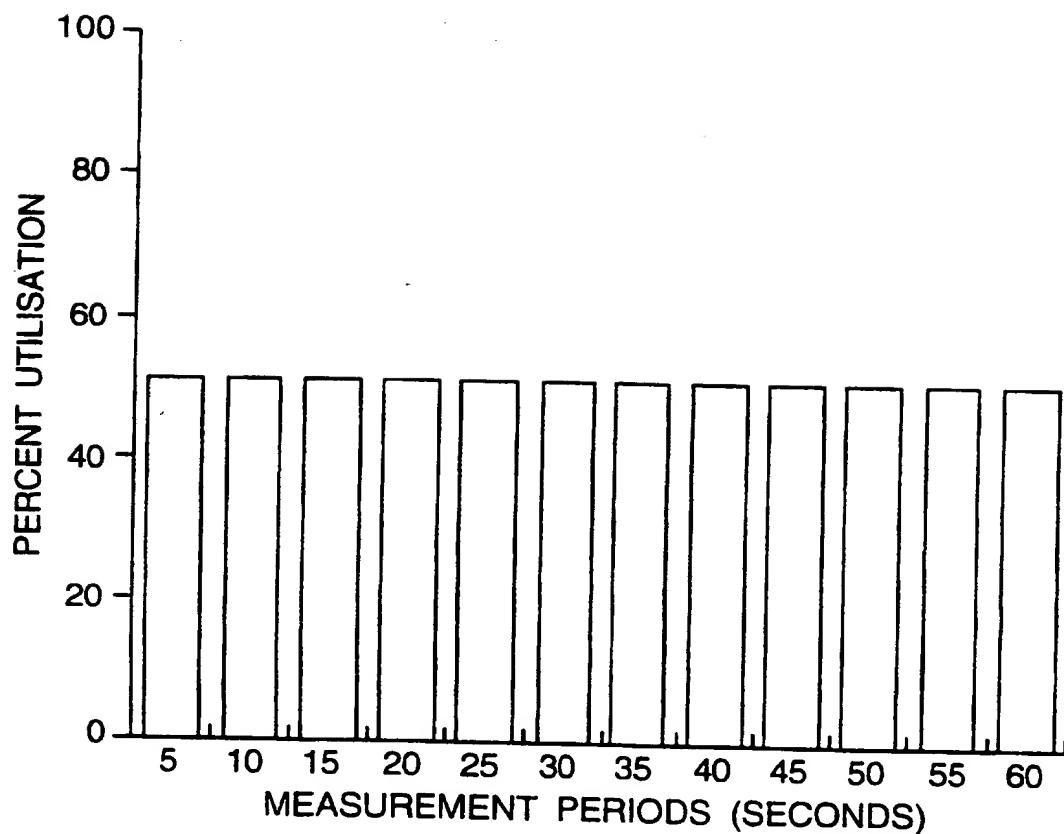


Fig.7.



INTERNATIONAL SEARCH REPORT

Internal Application No

PCT/GB 97/00752

A. CLASSIFICATION OF SUBJECT MATTER
 IPC 6 H04J3/16 H04J3/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 IPC 6 H04J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2 277 852 A (GPT LIMITED) 9 November 1994	1,3-6, 8-11
A	see page 4, line 15 - line 18 see page 11, line 2 - line 15 see page 14, paragraph 4 - paragraph 5 see page 15, line 25 - line 36; figure 13 ---	2,7
X	WO 93 25031 A (NOKIA TELECOMMUNICATIONS OY) 9 December 1993	1,6
A	see page 7, line 18 - line 33 see page 11, line 17 - page 12, line 13 see page 13, line 30 - page 14, line 24 see claim 3 ---	2-5,7-11
		-/-

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

* Special categories of cited documents :

- *'A' document defining the general state of the art which is not considered to be of particular relevance
- *'E' earlier document but published on or after the international filing date
- *'L' document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *'O' document referring to an oral disclosure, use, exhibition or other means
- *'P' document published prior to the international filing date but later than the priority date claimed

- *'T' later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *'X' document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *'Y' document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- *'&' document member of the same patent family

2

Date of the actual completion of the international search

25 June 1997

Date of mailing of the international search report

30.06.97

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
 NL - 2280 HV Rijswijk
 Tel. (- 31-70) 340-2040, Tx. 31 651 epo nl,
 Fax (- 31-70) 340-3016

Authorized officer

Pieper, T

INTERNATIONAL SEARCH REPORT

Internal Application No
PCT/GB 97/00752

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	IEEE INTERNATIONAL CONFERENCE ON COMMUNICATIONS ICC '90 INCLUDING SUPERCOMM TECHNICAL SESSIONS. SUPERCOMM ICC '90 CONFERENCE RECORD (CAT. NO.90CH2829-0), ATLANTA, GA, USA, 16-19 APRIL 1990, 1990, NEW YORK, NY, USA, IEEE, USA, pages 919-923 vol.3, XP000145970 WHITT S ET AL: "The role of SONET-based networks in British Telecom" see page 921, left-hand column, line 38 - line 53 ---	1,6
A	see page 921, left-hand column, line 38 - line 53 ---	2-5,7-11
Y	EP 0 539 758 A (ALCATEL N.V.) 5 May 1993	1,6
A	see page 6, line 35 - line 56 see page 14, line 26 - line 29 see page 14, line 52 - line 57 see claim 1 ---	2-5,7-11
A	US 5 315 594 A (NOSER) 24 May 1994 see column 15, line 13 - line 53 -----	1,6

INTERNATIONAL SEARCH REPORT

Information on patent family members

Internal Application No

PCT/GB 97/00752

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
GB 2277852 A	09-11-94	EP 0649581 A		26-04-95
		WO 9427387 A		24-11-94
WO 9325031 A	09-12-93	AU 671279 B		22-08-96
		AU 4072893 A		30-12-93
		EP 0645065 A		29-03-95
		JP 7507426 T		10-08-95
		NZ 252190 A		21-12-95
EP 539758 A	05-05-93	US 5210762 A		11-05-93
		AT 149067 T		15-03-97
		CA 2079631 A		03-04-93
		DE 69217533 D		27-03-97
US 5315594 A	24-05-94	AU 3373493 A		09-09-93
		CA 2090664 A		03-09-93
		EP 0559091 A		08-09-93
		NZ 245919 A		26-07-95